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Relation of Biomass to Basal Area and Site Index on an Appalachian Watershed

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Abstract

The biomass of 50-year-old cove hardwood and upland oak stands on an Appalachian watershed was more strongly related to basal area than to site index. Equations are presented for predicting the green and dry weight per acre of biomass components with basal area as the independent variable.

The advent of whole-tree chipping operations in Appalachian hardwood stands has stimulated interest in techniques for estimating biomass. Stuart et al. (1980) and Baumgras (1984) used basal area as a variable for making these estimates. Wiant and Fountain (1980) found that oak site index was a poor predictor of biomass.

Procedure

An intensive study of the relationships between forest biomass and both basal area and site index was conducted on the 665-acre Little Laurel Watershed located on the West Virginia University Forest near Morgantown. This watershed supports a 50-year-old forest. The topography and vegetation has been described by Tajchman and Wiant (1983) and Wiant and Knight (1981). Briefly, about 60 percent of the stands are in the upland oak type, dominated by white, chestnut, scarlet, northern red, or black oaks, and 40 percent in the cove hardwood type, dominated by yellow-poplar, black cherry, and northern red oak.

A sample of 242 square plots, each 1/4-acre in size and 3.7 chains apart, was established on lines 7.3 chains apart. There were 95 plots in cove hardwoods and 147 plots in upland oaks. The dbh and species for all trees 2 inches dbh or larger were determined for basal area and weight estimates by equations of Wiant et al. (1977). Three dominant or codominant oaks on each plot were selected for site index determinations according to the formulation of Schnur's curves given by Wiant (1975).

Biomass estimates included total tree green and dry weight excluding a 1/2-foot stump, roots, and leaves; green and dry bole weight to a 4-inch outside bark top diameter; dry weight of total tree bark; and dry weight of bark to a 4-inch top.

For basal area, oak site index, and total tree green weight, the average and range of sample plot values are:

Cove hardwoods	*Average*	*Range*
Basal area, ft^2/acre	120	52-169
Oak site index, feet (50-year basis)	76	58-91
Total tree biomass, green tons/acre	140	56-200

Upland oaks	*Average*	*Range*
Basal area, ft^2/acre	104	48-166
Oak site index, feet (50-year-basis)	72	52-98
Total tree biomass, green tons/acre	119	53-274

Results

A highly significant relation was found between site index and biomass component weight, but site index accounted for only 5 to 14 percent of the variation in the per-acre weight of biomass components (Table 1). Wiant and Fountain (1980) reported similar findings. With the exception of the total tree bark equations, covariance analysis indicated equations for cove hardwoods and upland oaks differed at the 0.01 level.

Basal area showed a highly significant relation to biomass, and accounted for 67 to 86 percent of the variation in the per-acre weight of biomass components (Table 2). Again, covariance analysis indicated that equations for cove hardwoods and upland oaks differed significantly at the 0.01 level.

The total tree green-weight equation for both cove hardwoods and upland oaks combined agreed well with those presented by Stuart et al. (1980) and Baumgras (1984) (Table 3). The application of the equations using basal area to estimate biomass should be limited to Appalachian hardwood stands similar to those sampled with respect to site index and age.

Table 1.—Linear regression coefficients and R^2 values for equations of the form $y = a + bx$, where y = biomass component weight (tons/acre), and x = oak site index (50-year basis)

Biomass Component	Cove hardwood			Upland oaks			Both		
	a	b	r^2	a	b	r^2	a	b	r^2
Total tree, green	34.6	1.378	0.07**	26.3	1.273	0.08**	11.3	1.565	0.11**
Total tree, dry	20.5	0.710	0.08**	14.9	0.728	0.08**	7.3	0.873	0.11**
Stem to 4-inch top, green	34.0	1.004	0.05*	10.5	1.039	0.11**	−6.6	1.383	0.14**
Stem to 4-inch top, dry	20.0	0.560	0.05*	1.5	0.612	0.10**	−2.7	0.778	0.13**
Total bark, dry	1.6	0.115	0.08**	3.6	0.082	0.06**	2.7	0.097	0.08**
Bark to 4-inch top, dry	1.2	0.087	0.08**	1.5	0.070	0.08**	0.4	0.090	0.12**

* $P < 0.05$.
** $P < 0.01$.

Table 2.—Linear regression coefficients and R^2 values for equations of the form $y = a + bx$, where y = biomass component weight (tons/acre) and x = basal area in trees $\geqslant$ 2.0 inches dbh (ft²/acre)

Biomass component	Cove hardwood			Upland oaks			Both		
	a	b	r^2	a	b	r^2	a	b	r^2
Total tree, green	11.0	1.068	0.71**	−36.4	1.480	0.83**	−16.9	1.297	0.77**
Total tree, dry	6.7	0.595	0.67**	−21.8	0.854	0.83**	−9.3	0.733	0.77**
Stem to 4-inch top, green	−0.5	0.926	0.76**	−27.3	1.080	0.86**	−23.7	1.077	0.83**
Stem to 4-inch top, dry	2.3	0.501	0.72**	−19.4	0.660	0.83**	−13.3	0.614	0.81**
Total bark, dry	0.3	0.083	0.74**	−18.8	0.734	0.77**	−0.5	0.094	0.77**
Bark to 4-inch top, dry	0.1	0.064	0.76**	−2.0	0.082	0.85**	−1.2	0.074	0.83**

** $P < 0.01$.

Table 3.—Comparison of total-tree green weight predictions from this and other studies; basal area is the independent variable

Basal area (ft²/acre)	This study	Stuart et al. 1980	Baumgras 1984
	Green tons/acre		
50	48	55	55
100	113	110	116
150	178	165	177
200	243	220	239

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